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Delivering Energy to Improve Lives

Summary of Kinder Morgan Technical Testimony: Engines and Turbines (Section 113)

Proposed Rule 20.2.50 – Oil and Gas Sector – Ozone Precursor Pollutants
Commencement of Hearing: September 20, 2021

Testimony of Mr. Vincent Brindley Engines and Turbines (Section 113)

Technical Witness

- Vincent Brindley, Technical Supervisor, Kinder Morgan

- Resume and qualifications at Exhibit II of the Kinder Morgan NOI to Present Direct Technical Testimony

Overview

Mr. Vincent Brindley

- Introduction to engines and turbines in the transmission sector

Mr. James Trent

- Support for NMED's revisions in September 16 draft
- Clarification of certain of NMED's direct testimony

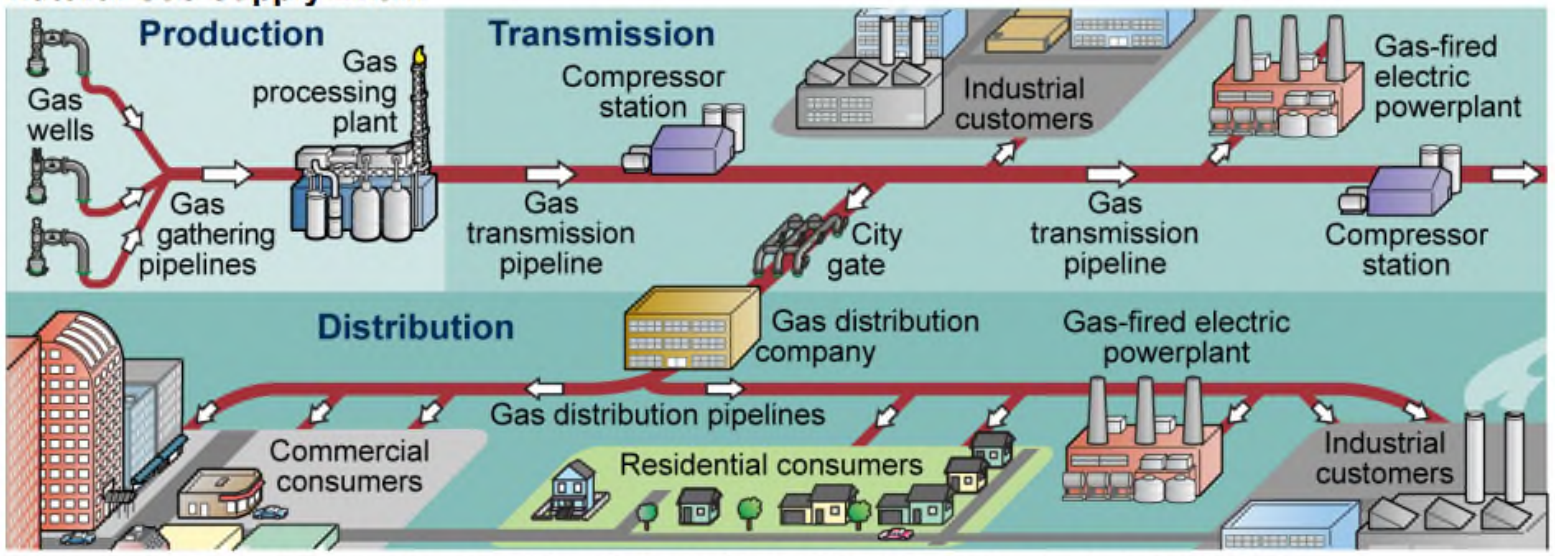
Ms. Leslie Nolting

- Exemption for emergency engines
- Maintenance requirements for engines and turbines

The Transmission Segment

- Kinder Morgan transports pipeline quality gas through an interstate pipeline network to residential, commercial and other industrial consumers.
  - Regulated by FERC and PHMSA.

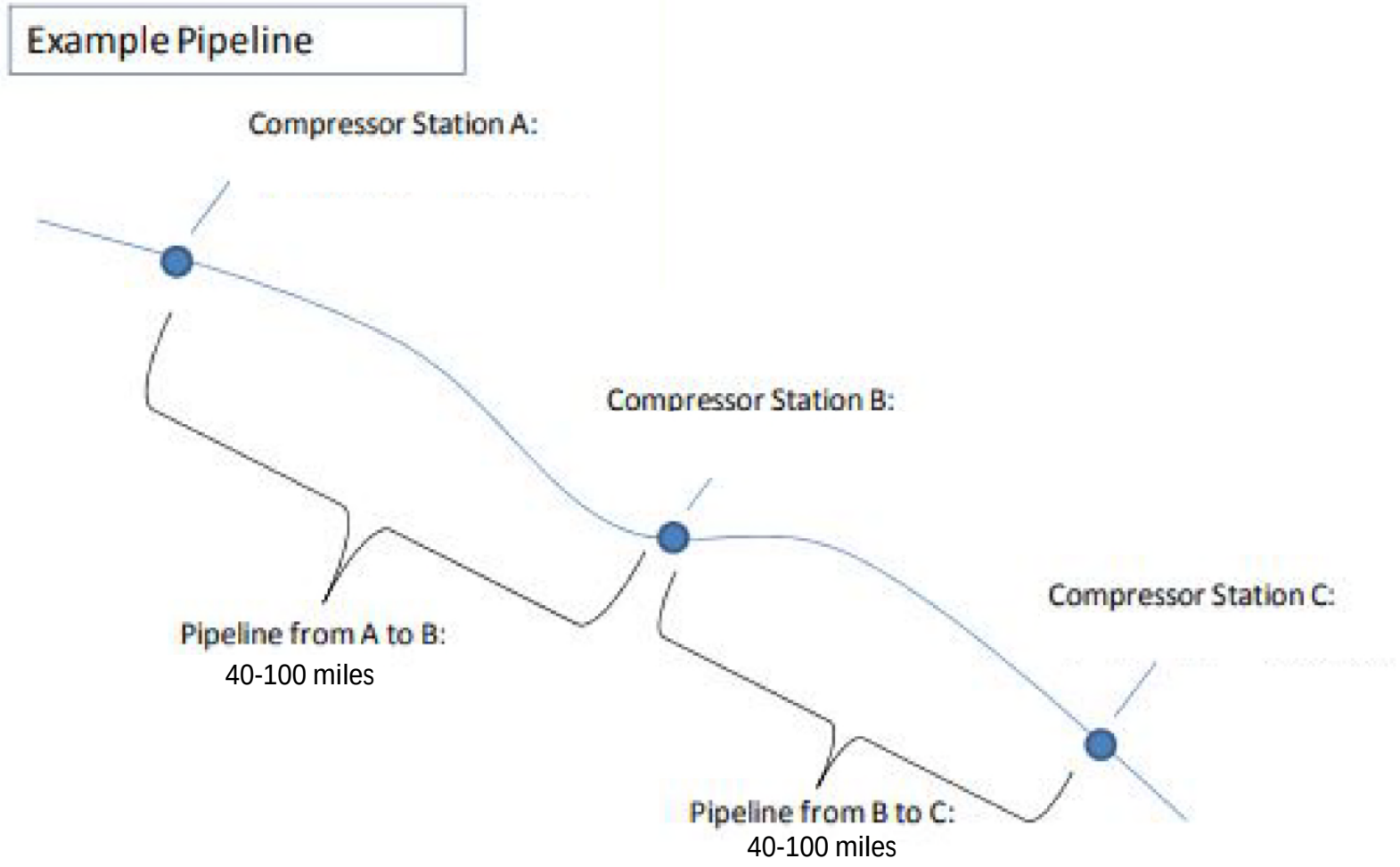
Selected Elements in the Production, Transmission, and Distribution Sectors of the U.S. Natural Gas Supply Chain



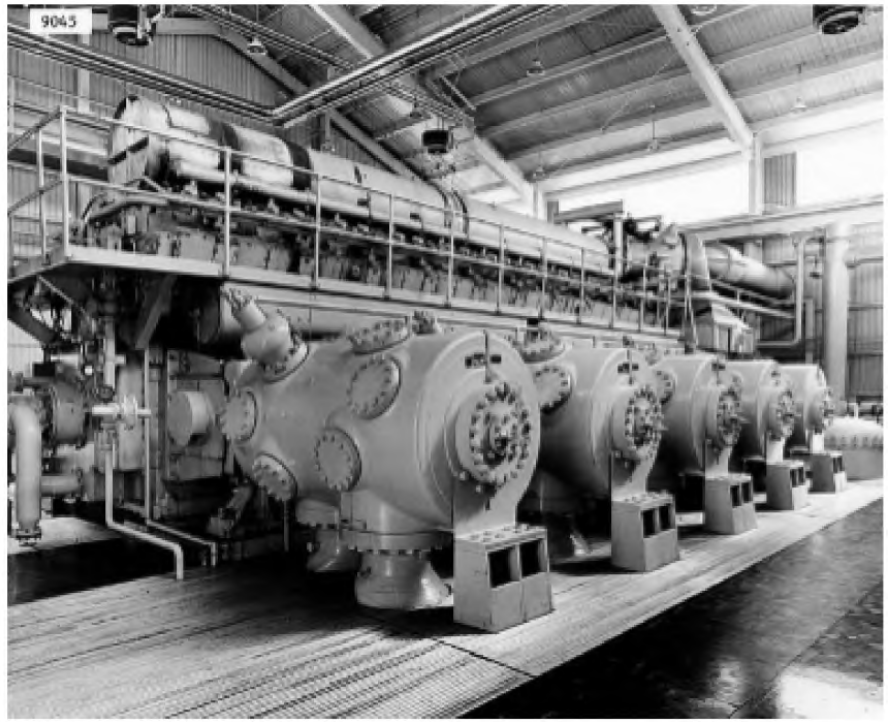
Source: GAO analysis of Energy Information Administration and Natural Gas Council documents. | GAO-20-658

- Engines and turbines in the transmissions segment are critical to ensure timely and necessary availability of and access to natural gas.

The Transmission Segment



Engines and Turbines in the Transmission Sector



Engine

Turbine

Testimony of Mr. James Trent Engines and Turbines (Section 113)

Technical Witness

- James Trent, Staff Engineer, Kinder Morgan

- Resume and qualifications at Exhibit III of the Kinder Morgan NOI to Present Direct Technical Testimony

Overview

- Support for NMED's revisions in September 16 draft
  - Engines and turbines standards
  - Compliance schedule for turbines
  - Operating hours reductions provisions
  - Engine load equation
- Clarification of certain of NMED's direct testimony

Kinder Morgan's Response to NMED's Revisions in the September 16 Draft Rule

NMED's Revisions in September 16 Draft

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NMED made various positive changes reflected in the September 16 Draft:

- Updated standards for new and existing engines and turbines
- Added compliance schedule for turbine retrofits
- Revised engine operating hours reduction provision; added same for turbines
- Revised engine load equation

We support these changes, and thank NMED for its responsiveness to stakeholder input.

NMED's Revisions in September 16 Draft

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Engines

NEW

Table 1 - EMISSION STANDARDS FOR NATURAL GAS-FIRED SPARK-IGNITION ENGINES CONSTRUCTED OR~~,~~ RECONSTRUCTED~~, OR INSTALLED~~ BEFORE THE EFFECTIVE DATE OF 20.2.50 NMAC~~.~~

Engine Type	Rated bhp	NO_x	CO	NMNEHC (as propane)
2 Stroke Lean Burn	>1,000	3.0 g/bhp-hr	0.60 g/bhp-hr	0.70 g/bhp-hr
4-Stroke Lean Burn	>1,000 bhp and <1,775 bhp	2.0 g/bhp-hr	0.60 g/bhp-hr	0.70 g/bhp-hr
4-Stroke Lean Burn	≥1,775 bhp	0.5 g/bhp-hr	0.60 g/bhp-hr	0.70 g/bhp-hr
Rich Burn	>1,000 bhp	0.5 g/bhp-hr	0.60 g/bhp-hr	0.70 g/bhp-hr
~~Lean-burn~~	~~>1,000~~	~~0.50 g/bhp-hr~~	~~47 ppmvd @ 15% O_2 or 93% reduction~~	~~0.70 g/bhp-hr~~
~~Rich-burn~~	~~>1,000~~	~~0.50 g/bhp-hr~~	~~0.60 g/bhp-hr~~	~~0.70 g/bhp-hr~~

EXISTING

Table 2 - EMISSION STANDARDS FOR NATURAL GAS-FIRED SPARK-IGNITION ENGINES CONSTRUCTED OR~~,~~ RECONSTRUCTED~~, OR INSTALLED~~ AFTER THE EFFECTIVE DATE OF 20.2.50 NMAC~~.~~

Engine Type	Rated bhp	NO_x	CO	NMNEHC (as propane)
~~Lean-burn~~	~~>500 - <1,000~~	~~0.50 g/bhp-hr~~	~~0.60 g/bhp-hr~~	~~0.70 g/bhp-hr~~
Lean-burn	> 500 and~~≥1,000~~ < 1875	0.5~~3~~0 g/bhp-hr ~~uncontrolled or 0.05 g/bhp-hr with control~~	0.60 g/bhp-hr	0.70 g/bhp-hr
Lean-burn	≥ 1875	0.30 g/bhp-hr	0.60 g/bhp-hr	0.70 g/bhp-hr
Rich-burn	>500	0.50 g/bhp-hr	0.60 g/bhp-hr	0.70 g/bhp-hr

Kinder Morgan can support these new limits.

NMED's Revisions in September 16 Draft

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Turbines

NEW

EXISTING

Table 3 - EMISSION STANDARDS FOR STATIONARY COMBUSTION TURBINES

Turbine Rating (bhp)	NO_x (ppmvd @15% O_2)	CO (ppmvd @ 15% O_2)	NMNEHC (as propane, ppmvd @15% O_2)
For each applicable natural gas-fired combustion turbine constructed or reconstructed ~~and installed~~ before the effective date of 20.2.50 NMAC, the owner or operator shall ensure the turbine does not exceed the following emission standards no later than ~~two years from the effective date of this Part~~the schedule set forth in Paragraph (7)(a) of Subsection B of 20.2.50.113 NMAC:			
≥1,000 and <~~4~~5,000	150	50	9
≥~~4~~5,000 and <15,000	50	50	9
≥15,000	50	50 or 93% reduction	5 or 50% reduction
For each applicable natural gas-fired combustion turbine constructed or reconstructed ~~and installed~~ on or after the effective date of 20.2.50 NMAC, the owner or operator shall ensure the turbine does not exceed the following emission standards upon startup:			
Turbine Rating (bhp)	NO_x (ppmvd @15% O_2)	CO (ppmvd @ 15% O_2)	NMNEHC (as propane, ppmvd @15% O_2)
≥1,000 and <~~4~~5,000	~~25~~100	25	9
≥~~4~~5,000 and <15,900	15	10	9
≥15,900	9.0 Uncontrolled or 2.0 with Control	10 Uncontrolled or 1.8 with Control	5

Kinder Morgan can support these new limits.

NMED's Revisions in September 16 Draft

Turbine Rating (bhp)	NO_x (ppmvd @15% O_2)
≥1,000 and <4~~5~~,000	150
≥4~~5~~,000 and <15,000	50

The changes for existing turbines are critically important

1. For turbines in 1,000-4,000 bhp range, meeting 50 ppm NOx would require SCR, which is exorbitantly expensive
   - *E.g.*, at our Rio Vista station, installing SCR would cost ~$974,508 per ton of NOx reduced on one unit and ~$830,527 per ton of NOx reduced
2. As pointed out by Solar Turbines, water/steam injection is not available for most Solar turbines in this range; even where theoretically viable, questionable due to water use

NMED's Revisions in September 16 Draft

Turbine Rating (bhp)	NO_x (ppmvd @15% O_2)
≥1,000 and <4~~5~~,000	~~25~~100
≥4~~5~~,000 and <15,900	15
≥15,900	9.0 Uncontrolled or 2.0 with Control

The changes for new turbines are equally important

- No new turbines on market in 1,000-4,000 bhp range that meet 25 ppm NOx
- Would again require SCR

NMED's Revisions in September 16 Draft

Manufacturer	Unit Options
Solar Turbines – Caterpillar	Only products offered in 1,000–5,000 HP range are Saturn 20, Centaur 40, and Centaur 45. • Saturn 20: ISO rated at 2,000 HP. 100 ppm NO_x emissions. • Centaur 40: ISO rated at 4,500 HP. 25 ppm NO_x emissions. • Centaur 45: ISO rated between 4,700 and 5,000 HP. 15 ppm NO_x emissions.
Siemens Energy	Smallest unit offered is 4MW (5,300 HP).
Baker Hughes	Smallest unit offered is 5.5MW (7,800 HP).
GE Power	Smallest unit offered is 34.6MW (46,000 HP).
Capstone Turbine Corporation	Smallest unit is 30KW (40 HP), but only used for power generation.
Kawasaki Heavy Industries	Smallest unit is 1.5MW (2,000 HP), but only used for power generation.
OPRA Turbines	Smallest unit is 2MW (2,600 HP), but only used for power generation.
Centrax Gas Turbines	Smallest unit is 3MW (4,000 HP), but only used for power generation.
Ansaldo Energia	Smallest unit is 80MW (107,282 HP).
Mitsubishi Heavy Industries	Smallest unit is 40MW (53,000 HP).
MAN Energy Solutions	Smallest unit is 6.4MW (8,900 HP).

NMED's Revisions in September 16 Draft

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Compliance schedule to retrofit existing turbines:

- Two years would not have been enough time to retrofit turbines
- We operate roughly the same number of turbines that would need to be retrofit
- Retrofitting turbines is just as time- and cost-intensive as engines

NMED has implemented a compliance schedule similar to the schedule for engines (see Section 113.B.(7)(a)). We support this revision.

(a) The owner or operator of an existing stationary natural gas-fired combustion turbine shall complete an inventory of all existing turbines subject to Part 50 by July 1, 2023, and shall prepare a schedule to ensure that each subject existing turbine does not exceed the emission standards in table 3 of Paragraph (7) of Subsection B of 20.2.50.113 NMAC as follows, except as otherwise specified under an Alternative Compliance Plan approved pursuant to Paragraph (10) of Subsection B of 20.2.50.113:

(i) by January 1, 2024, the owner or operator shall ensure at least thirty percent of the company's existing turbines meet the emission standards.

(ii) by January 1, 2026, the owner or operator shall ensure at least an additional thirty-five percent of the company's existing turbines meet the emission standards.

(iii) by January 1, 2028, the owner or operator shall ensure that the remaining thirty-five percent of the company's existing turbines meet the emission standards.

(iv) in lieu of meeting the emission standards for an existing stationary natural gas-fired combustion turbine, an owner or operator may reduce the annual hours of operation of a turbine such that the annual PTE of NOx and VOC emissions are reduced to achieve an equivalent allowable ton per year emission reduction as set forth in table 3 of Paragraph (7) of Subsection B of 20.2.50.113 NMAC, or by at least ninety-five percent per year.

NMED's Revisions in September 16 Draft

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NMED's revisions to operating hours reduction provisions for engines and new provision for turbines:

(d) in lieu of meeting the emission standards for an existing natural gas-fired spark ignition engine, an owner or operator may reduce the annual hours of operation of an engine such that the annual PTE of NOx and VOC emissions are reduced to achieve an equivalent allowable ton per year emission reduction as set forth in table 1 of Paragraph (2) of Subsection B of 20.2.50.113 NMAC, or by at least ninety-five percent per year.

(iv) in lieu of meeting the emission standards for an existing stationary natural gas-fired combustion turbine, an owner or operator may reduce the annual hours of operation of a turbine such that the annual PTE of NOx and VOC emissions are reduced to achieve an equivalent allowable ton per year emission reduction as set forth in table 3 of Paragraph (7) of Subsection B of 20.2.50.113 NMAC, or by at least ninety-five percent per year.

- Revisions needed so that reductions well below standards not inadvertently required.

Kinder Morgan supports these revised provisions.

NMED's Revisions in September 16 Draft

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NMED's revision to engine load equation:

$$\text{Load (Hp)} = \frac{\text{Fuel consumption (scf/hr) x Measured fuel heating value (LHV btu/scf)}}{\text{Manufacturer's rated BSFC (btu/bhp-hr) at 100\% load or best efficiency}}$$

$$\text{Load (Hp)} = \frac{\text{Fuel consumption (gal/hr) x Measured fuel heating value (LHV btu/gal)}}{\text{Manufacturer's rated BSFC (btu/bhp-hr) at 100\% load or best efficiency}}$$

Where: LVH = lower heating value, btu/scf, or btu/gal, as appropriate; and
BSFC = brake specific fuel consumption

If the manufacturer's rated BSFC is not available, an operator may use an alternative load calculation methodology based on available data.

- Revision needed to account for unavailable manufacturer's rated BSFC.

Kinder Morgan supports this revised provision.

Clarifications to NMED's Direct Testimony

Clarifications to NMED's Direct Testimony

1. NMED's cost estimates for achieving the originally-proposed NOx and VOC standards

2. Availability of engine upgrades

Clarifications to NMED's Direct Testimony

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NMED provided estimates for achieving the originally-proposed standards. We provided written rebuttal testimony addressing these cost estimates.

A few themes:

- NMED appears to have *averaged* certain costs across newer and older units. This can distort the actual costs of retrofitting older units, which are typically far more expensive.
- The costs to control NOx from turbines <15,900 bhp were much lower than our estimates, likely because NMED did not evaluate SCR, only water/steam injection.
  - SCR estimate for turbines >15,900 bhp also lower than what we would expect.
- Costs to control VOCs from both engines and turbines also lower than our estimates.

While the standards have changed, we encourage the Board to review our written rebuttal testimony addressing NMED's cost estimates.

Clarifications to NMED's Direct Testimony

In direct testimony, NMED states that there are engine upgrades available for a number of engine models to meet a NOx limit of 0.5 g/bhp-hr.

Not the case for all engines, *e.g.*:

- Worthington SLHC, 1,200 HP engine
- Worthington Mainliner engine

Alternative Compliance Options

We support NMED's proposals for:

1. An Alternative Compliance Plan (ACP)
2. An individual alternative emission standard.

We will discuss these proposals further during sur-rebuttal.

Testimony of Ms. Leslie Nolting Engines and Turbines (Section 113)

Technical Witness

- Leslie Nolting, EHS Specialist / EHS Manager – Air Permitting Compliance, Kinder Morgan

- Resume and qualifications at Exhibit I of the Kinder Morgan NOI to Present Direct Technical Testimony

Overview

- Exemption for emergency engines
- Maintenance requirements for engines and turbines

Emergency Engines

Original Proposed Rules exempted emergency engines from the emission standards, but limited operation of such engines to less than 100 hours per year, even in emergencies.

HOWEVER: Federal law does not limit the number of hours that emergency engines can be operated during emergencies.

NMED incorporated our proposed revision:

(9~~10~~) The owner or operator of an emergency use engine as defined by 40 C.F.R. §§ 60.4211, 60.4243, or 63.6675 ~~that is operated less than 100 hours per year~~ is not subject to the emissions standards in this Part but shall be equipped with a non-resettable hour meter to monitor and record any hours of operation.

We support the language as revised.

Maintaining Engines and Turbines

Original Proposed Rules required that maintenance and repair of engines and turbines “meet the minimum manufacturer recommended maintenance schedule.”

- Often outdated or unavailable for older engines and turbines.

We offered the following revision:

(1) Maintenance and repair for a spark-ignition engine, compression-ignition engine, and stationary combustion turbine subject to an emission standard in Subsection B of 20.2.50.113 shall be consistent with ~~meet~~ the minimum manufacturer recommended maintenance schedule or good engineering and maintenance practices. The following maintenance, adjustment, replacement, or repair events for engines and turbines shall be documented as they occur:

NMED has implemented edits consistent with this revision in Section 112.A.(1). We support the revised language.

Questions?